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ABSTRACT

A study of children's and young adults' retention of words and their presentation modality addressed three issues: (1) how long the modality information is retained, (2) whether children or adults lose it more rapidly, and (3) whether the word or modality information is lost more rapidly. The study consisted of two experiments. In the first, 32 third- and fourth-grade students and 32 college students were divided, within each age group, into four delay groups: 0-hour, 4-hour, 1-day, and 7-day. In the second experiment, conducted to clarify a question of visual presentation arising in the first experiment, 16 college students were divided into two delay groups, 0-hour and 1-day. In the first experiment, subjects were presented with a continuous series of 200 nouns, half seen and half heard, and asked to judge whether each word was "new" or "old," and if "old," whether it had previously appeared in the same or a different modality. A second test was administered after the appropriate delay for the group. The second experiment was conducted similarly, with a change in the visual presentation and with only two delay groups. Results show that the forgetting rates for effortfully encoded information (word identification) and for automatically encoded information (presentation modality) do not vary from middle childhood to early adulthood. However, modality identification declines gradually with time, while word identification remains high initially and declines rapidly later. Information about input modes lasted at least 4 hours in both children and adults, with some remaining in memory for 7 days. (MSE)

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Long-Term Retention of Information about Presentation Modality
by Children and Adults*

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Evidence is accumulating that representations contain a great deal of information about presentation modality, i.e. whether something is seen or heard (Bray & Batchelder, 1972; Hintzman, Block, & Inskip, 1972; Kirsner, 1974; Lehman & Hanzel, 1981; Madigan & Doherty, 1972). Furthermore, it appears that both children and young adults process this kind of information "automatically" in the sense that minimal attention is required. Three of Hasher and Zacks' (1979) proposed criteria for automaticity have been met: no developmental change, no difference between incidental and intentional instructions, and no interference with other operations going on at the same time (Lehman, 1982).

Recently, the emphasis has shifted from identifying automatically encoded attributes to comparing automatic and effortful memory tasks on various dimensions within the same subjects (Attig, 1983). In the present studies long-term retention for words and their presentation modality (assumed to be effortful and automatic tasks, respectively) was investigated. Three questions were asked. First, how long does modality information last? Second, is it lost more rapidly by children than by adults? Third, is it lost more rapidly than information about words? The obtained decay functions add to the small group of developmental studies on forgetting of effortfully

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acquired information (Berch & Evans, 1973; Fajnsztejn-Pollack, 1973; Sophian & Perlmutter, 1980; Wickelgren, 1975). They also provide the first data on forgetting rates of automatically encoded information in children and adults.

A continuous mixed-modality recognition task based on one designed by Kirsner (1974) was employed in order to minimize the influence of age-related mnemonic strategies and to generate enough data points for retention functions to be drawn (Berch, 1975). In Experiment 1, third- and fourth-grade children and college students were presented with a continuous series of 200 nouns, half seen and half heard, and asked to judge whether each word was "New" or "Old" and, if "Old," whether it appeared in the "Same" or in a "Different" modality as before. A final recognition test was also administered either immediately or after 4-hours, 1-day, or 7-days. In Experiment 2, a change was made in the presentation of the visual stimuli to college students in order to clarify a question about modality effects that arose in the first experiment. The long-term test occurred either immediately or after 1-day.

(4) Subjects

Thirty-two third- and fourth-grade children and 32 college students participated in Experiment 1. Within each age group, 8 subjects (approximately equal numbers of males and females) were assigned to each delay group: 0-hour, 4-hour, 1-day, and 7-days. Sixteen college students were tested in Experiment 2. A 0-hour delay group and a 1-day delay group were each composed of 2 males and 6 females.

(5) Procedure

Subjects were tested individually on an immediate retention test and on a long-term retention test after a pretraining session. The procedure

required a total of approximately 40 minutes to complete.

On the immediate test a mixed-modality continuous recognition task with lags of 0, 5, 10, 25, and 50 was administered. Eighty nouns from first- and second-grade readers were selected as duplicates, half presented in the same and half in a different modality from their first appearance in the list, and 40 nouns were chosen as "fillers," i.e. to be presented only once. Visually-presented words were typed in orator-size print on 3x5 inch cards. Auditorily-presented words were spoken by the experimenter while a blank 3x5 inch card was turned over. On each trial subjects responded either "Same", "Different", or "New." In Experiment 1 the cards, and thus the visual words, remained visible until a response was made. In Experiment 2, on the other hand, the cards were turned over, subjects either heard or saw a word, and after 2 seconds the cards were removed whether or not the judgment had been made.

On the long-term test, recognition of the 40 filler words from the immediate test was assessed after delays of 0-hours, 4-hours, 1-day, and 7-days in Experiment 1 and 0-hours and 1-day in Experiment 2. The filler words were presented with cards as above, half in the same modality and half in a different modality from their appearance on the immediate test, along with 20 brand new nouns which were presented only once. Subjects again judged "Same", "Different", or "New."

(6) Results or Findings

Experiment 1

Modality identification. Conditional proportions of correct modality identification given word recognition were calculated in order to separate occurrence and modality judgments and to provide some control over age-related differences in response bias. In order to examine changes in performance over

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time, these conditional proportions were subjected to a 2(age) by 6(lag) by 4(modality combination) analysis of variance. The major finding from this analysis was that the critical age by lag interaction was not statistically significant, $F < 1$. Comparable forgetting rates in the two age groups were also found in regression analyses. There were significant and similar declines at the two ages for words presented auditorily first (i.e. AA & AV), children: $r = .87$, slope = $-.06$, $F(1,155) = 68.22$, $p < .001$; adults: $r = .82$, slope = $-.06$, $F(1,55) = 123.91$, $p < .001$, and for words presented visually first (i.e. VV & VA), children: $r = .88$, slope = $-.02$, $F(1,155) = 32.20$, $p < .001$; adults: $r = .91$, slope = $-.04$, $F(1,155) = 56.86$, $p < .001$. The data were analyzed separately by first modality because the original analysis of variance indicated that modality identification decreased more across lags for AA and AV presentations than for VV and VA presentations, $F(15,930) = 8.26$, $p < .001$. (See Figure 1)

Retention of modality information over the long term was well above chance even after seven days for words that had been seen first. This was true for both children and adults (7-day retention in children = .81, in adults = .86). Information presented first by ear, on the other hand, was remembered better than chance only up to 4-hours. In both age groups at 1-day performance on words presented auditorily first was no better than chance (children = .56; adults = .49). An analysis of variance on difference scores between immediate and long-term retention added some additional findings. First, the drop in modality identification across delays occurred for AA and AV, but not for VV and VA, $F(3,56) = 11.69$, $p < .001$. Second, a difference between age groups appeared only at the 7-day interval, when the drop for children was greater than the drop for adults, $F(3,56) = 3.44$, $p < .05$. Difference scores were used in this analysis because of some differences in modality

identification among the four delay groups on the immediate test.

Word identification. A 2(age) by 6(lag) by 4(modality combination) analysis of variance on the proportions of correct word identifications demonstrated that the critical age by lag interaction was not statistically significant, $F(5,310)=1.55$, NS. Regression analyses supported this finding, children: $r=.91$, slope $=-.08$, $F(1,155)=307.01$, $p<.001$; adults: $r=.86$, slope $=-.06$, $F(1,155)=314.64$, $p<.001$. Although a significant main effect of age occurred in the analysis of variance done on the word identification proportions, $F(1,62)=7.26$, $p<.01$, the difference disappeared when the same analysis was performed on the d' scores. The effect was probably due to the higher false alarm rates of the adults. First modality of presentation did not influence the word identification results. (See Figure 2)

Retention of information about whether or not a word had been presented before was above chance in children only at 0-hours (.72) and at 4-hours (.65) and in adults at 0-hours (.73), 1-day (.63), and 7-days (.61). A 2(age) by 4(delay) by 4(modality combination) analysis of variance on the word identification proportions revealed that, overall, fewer words were correctly identified as "Old" as the delay increased, that performance was lower in the AV condition than in any other, and that the only statistically significant difference between age groups occurred after 7-days. At this time children recognized fewer words than did adults.

Experiment 2

The main concern in Experiment 2 was whether the more accurate identification of modality which occurred for words that had been presented visually first was due to the somewhat longer exposure of the visually presented words.

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Consequently, in Experiment 2 each card, whether the word was seen or heard, was exposed for only 2 seconds and then removed. The procedural change had no effect on the results. Proportion correct modality identification on the immediate test was .82 for words presented auditorily first and .92 for words presented visually first. On the long-term test the proportions were .54 and .85.

(7) Implications and Conclusions

1. Forgetting rates for information encoded effortfully (word identification) and for information encoded automatically (presentation modality) are invariant from middle childhood to young adulthood.

2. The form of the forgetting curve, however, may depend on whether the information was encoded effortfully or automatically. Modality identification, for example, declines gradually with time; word identification remains high initially, and then declines more rapidly. (See Figure 3)

3. Information about input mode lasts for at least four hours in both children and adults. Some types, e.g. that a word was seen, may remain in memory for as many as 7 days.

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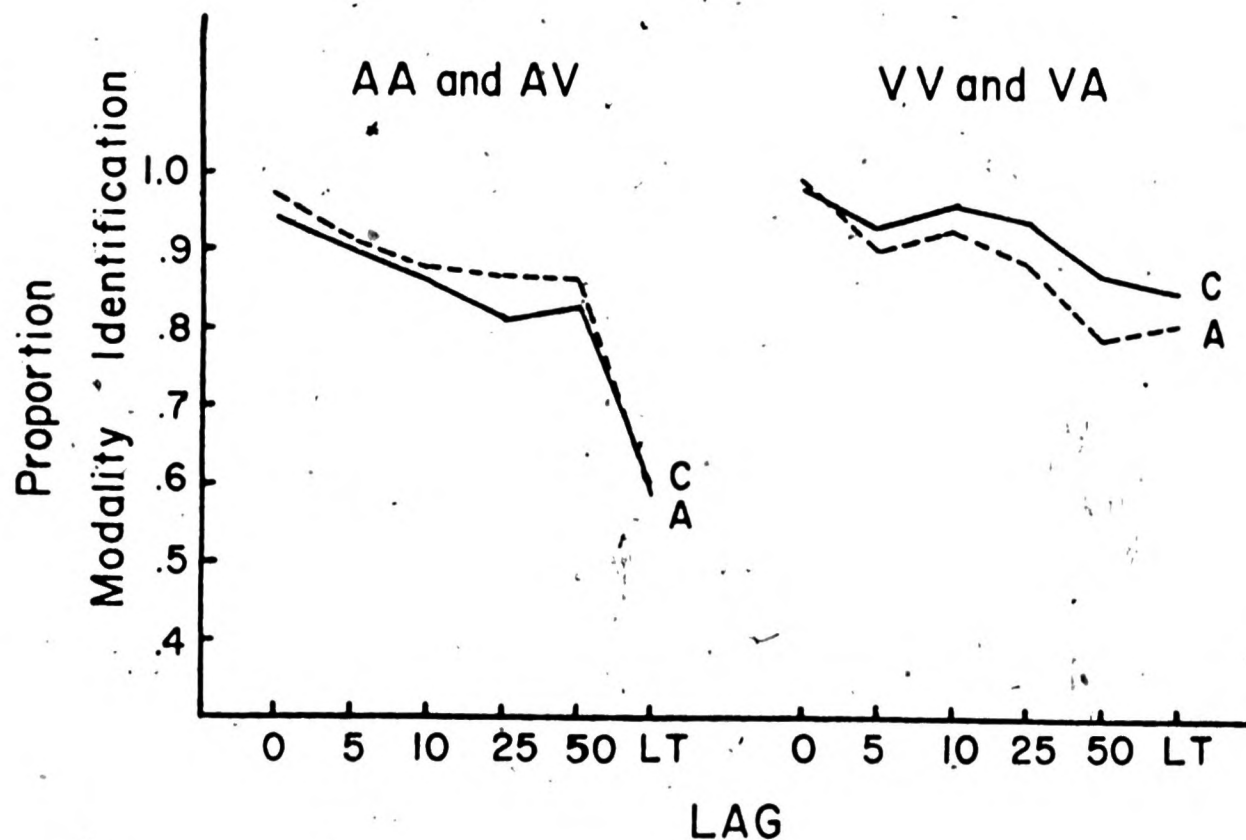


Figure 1. Experiment 1: Conditional proportions of correct modality identification, given word recognition, across lags for words presented auditorily first (AA & AV) and visually first (VV & VA) by children (C) and adults (A).

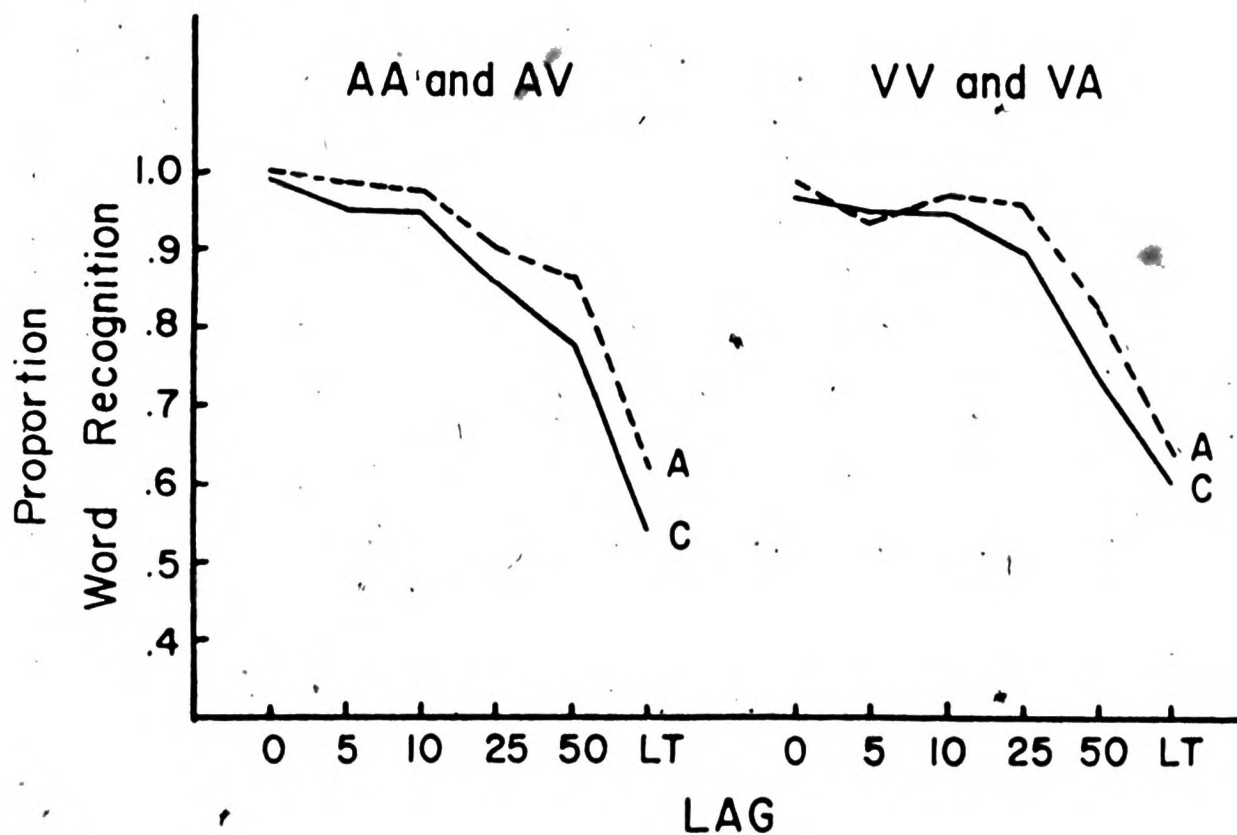


Figure 2. Experiment 1: Proportions of correct word recognition across lags for words presented auditorily first (AA & AV) and visually first (VV & VA) by children (C) and adults (A).

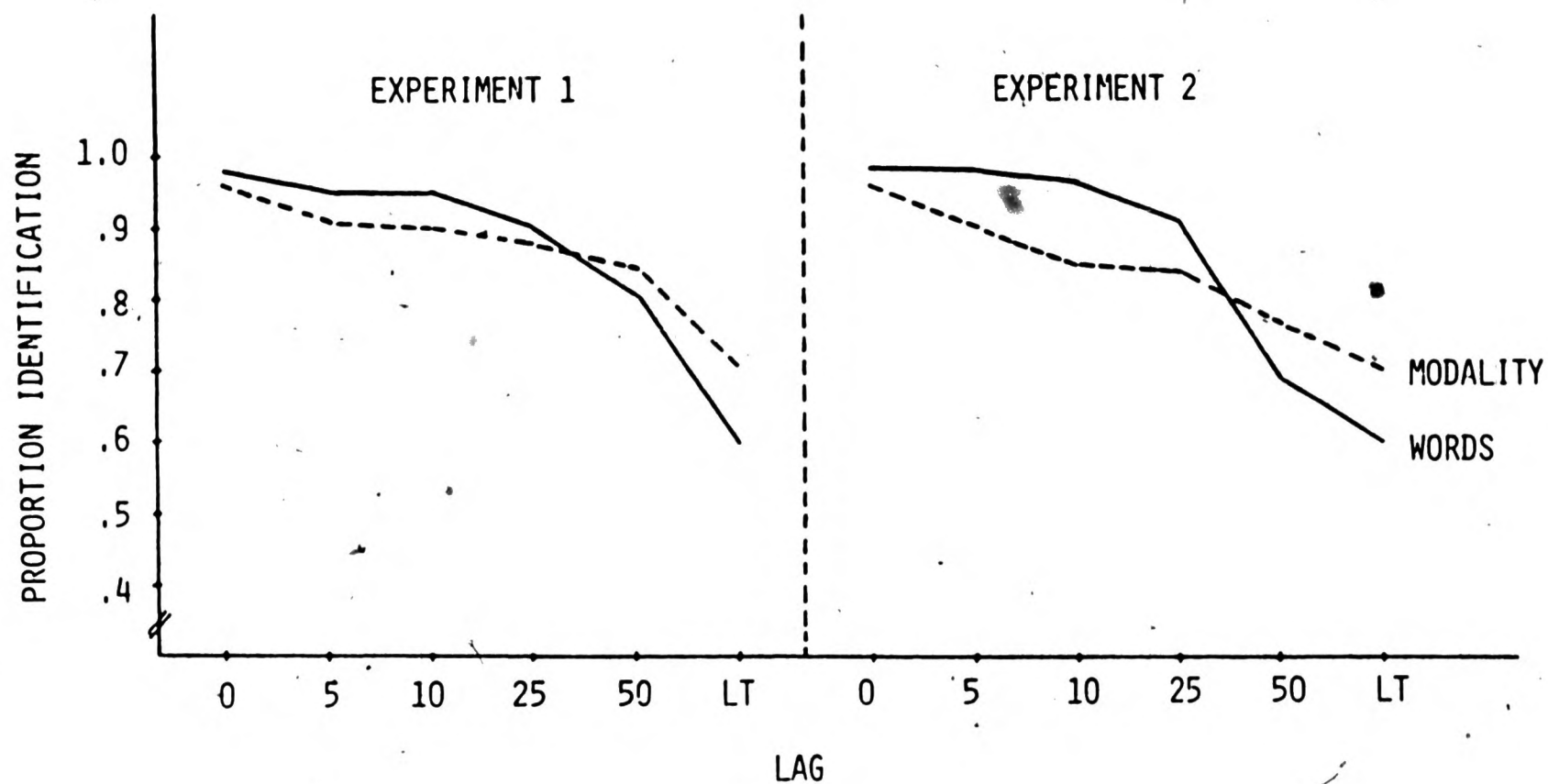


Figure 3. Proportions of correct word recognition and modality identification (given word recognition) across lags.